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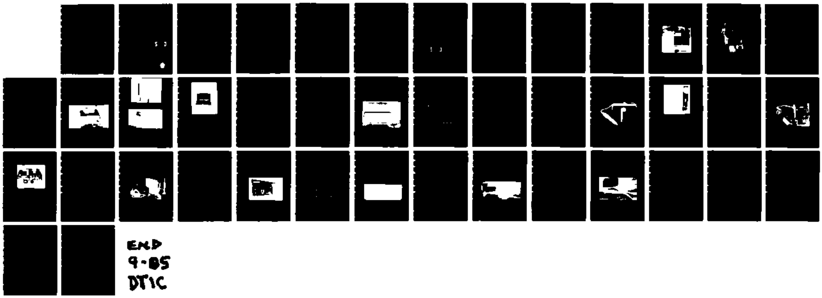

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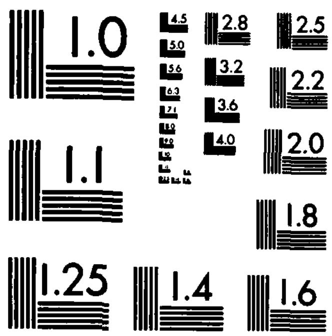

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DENTAL ELECTRIC HANDENGINES
Test and Evaluation

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Final Report for Period February 1984 – February 1985

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USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, TX 78235-5301

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NOTICES

This final report was submitted by personnel of the Dental Investigation Service, Clinical Sciences Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order DSB38200.

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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The purpose of this study was to provide assistance to the base dental surgeons for selection of dental electric handengines. The study included the test and evaluation of different dental electric handengines from eight manufacturers. The speed and torque characteristics were compared by using a hysteresis electric dynamometer. The physical characteristics, weight, size, and cost were also compared. Medical maintenance personnel evaluated quality and maintainability of the units. Seventy-two U.S. Air Force dental laboratory technicians performed a user evaluation on each dental electric handengine.

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DENTAL ELECTRIC HANDENGINES

Test and Evaluation

INTRODUCTION

Presently there are no nationally or internationally accepted design standards, specifications, or performance characteristics for dental electric handengines. Because of the absence of these criteria, some means of evaluation had to be established to allow the U.S. Air Force to purchase quality laboratory handengines.

The U.S. Air Force Dental Investigation Service (DIS) established Project 84-7 to compare the dental electric handengines of several manufacturers. This report describes the test and evaluation methods and the results of these studies. The information from this report can be used by base dental surgeons to assist in the selection of dental handengines to meet their particular requirements.

TEST METHODS AND EQUIPMENT

Physical Characteristics

The physical characteristics of each handengine were measured for size and weight. The units were evaluated according to the type of controls and length of cord attachments.

Handengine Power

To obtain the power of each handengine, it was necessary to find the speed at which it rotated when varying amounts of torque were applied. The handengines were connected by mandrel to a Magtrol (Model No. HD-100-7) Dynamometer which contained the electromagnetic braking system for increasing the torque.

The Dynamometer was controlled by a Magtrol (Model No. 4619) Dynamometer Controller and Magtrol (Model No. 4605C) Digital Indicator. The controller was used to automatically increase the torque at a constant rate from zero to stall torque for each handengine. The signals from the controller were transported to a Hewlett-Packard (Model No. 7047A) X-Y Recorder which produced torque versus speed curves.

Each handengine was operated at the working speeds of 5,000, 10,000, 15,000, 20,000, 25,000, and 30,000 revolutions per minute (rpm), and torque was increased until the handengine stalled at each speed. Some handengines did not reach 30,000 rpm; therefore, they were only tested to maximum speed. The power of the handengines was calculated, in watts, with the data from the torque versus speed curves.

Sound Levels

The noise levels produced by the handengines were recorded by a General Radio (Model No. M1982) Sound Level Meter and Analyzer. The sound levels were measured at 18 in. perpendicular to the handengines, with the handengines running at maximum speed under no load.

Medical Maintenance Evaluation

A medical maintenance technician disassembled each handengine and control unit. Each piece of equipment was evaluated for the following:

a. Labeling of name, model number and serial number
b. Control unit construction
c. Control unit type
d. Fuses and circuit breakers
e. Electrical wiring
f. Electrical components
g. Literature availability
h. Handengine construction

User Evaluation

A user evaluation of the handengines was performed at the School of Health Care Sciences, Sheppard Air Force Base, Texas. This portion of the evaluation was monitored by TSgt Arlo H. King and SSgt Carolyn S. Stemple. Seventy-two dental laboratory technicians used each of the handengines and completed a questionnaire on the following:

a. Adequacy and clearness of directions
b. Special storage requirements
c. Stability
d. Ease of use
e. Strong and weak points
f. Comparison of similar items

The responses to these questions were compiled to establish user preferences.

EVALUATION OF DATA

Test Samples

The electric handengines that were evaluated are presented in Table 1.

TABLE 1. HANDENGINE DATA

Handengine	Power unit	Distributor
38L	C-33 Mark VIII Mark X DX	Bell International 1299 Old Bayshore Hwy. #203 Burlingame, CA 94010 (415) 348-2055
28L	C-35 Mark VIII Mark X	Bell International
KaVo 950 (K9 EWL)	900 920	Degussa Dental Inc. 21-25 44th Ave. Long Island City, NY 11101 (800) 221-0168
Odontomotor	Odontomotor Cassette	Erio System 12931 Brandywine Ct. Saratoga, CA 95070 (408) 867-7485
MFL Micromotor	LC 81 FC 81	FARO, U.S.A. Corp. 1320 Marsten Rd. Burlingame, CA 94010 (415) 348-3763
Syncro/Torque	No. 500	Handler Manfacturing Co. Inc. P.O. Box 459 612 North Ave. E Westfield, NJ 07090 (201) 233-7796
Dynamo 35	Dynamo 35	Jelenko 99 Business Park Dr. Armonk, NY 10504 (800) 431-1785
15 EHA Micro-Motor	15 EHA	Teledyne Emesco/Hanau P.O. Box 203 80 Sonwil Dr. Buffalo, NY 14225-0203 (716) 684-0110
Lab Electric	Power Unit	Unitek Corp. 2724 South Peck Rd. Monrovia, CA 91016 (213) 445-7960

As a means of comparison to existing systems, the Ney T-200 air-driven handpiece (Fig. 1) and the Buffalo 1/5 hp belt-driven (Fig. 2) handpiece were also used in the testing procedures. An interesting point to note is that as the starting speed of the air-driven and belt-driven handpieces decreased, the stall torque also decreased (Figs. 3 and 4). However, as the starting speed of the electric handengine decreased, the stall torque basically remained the same.

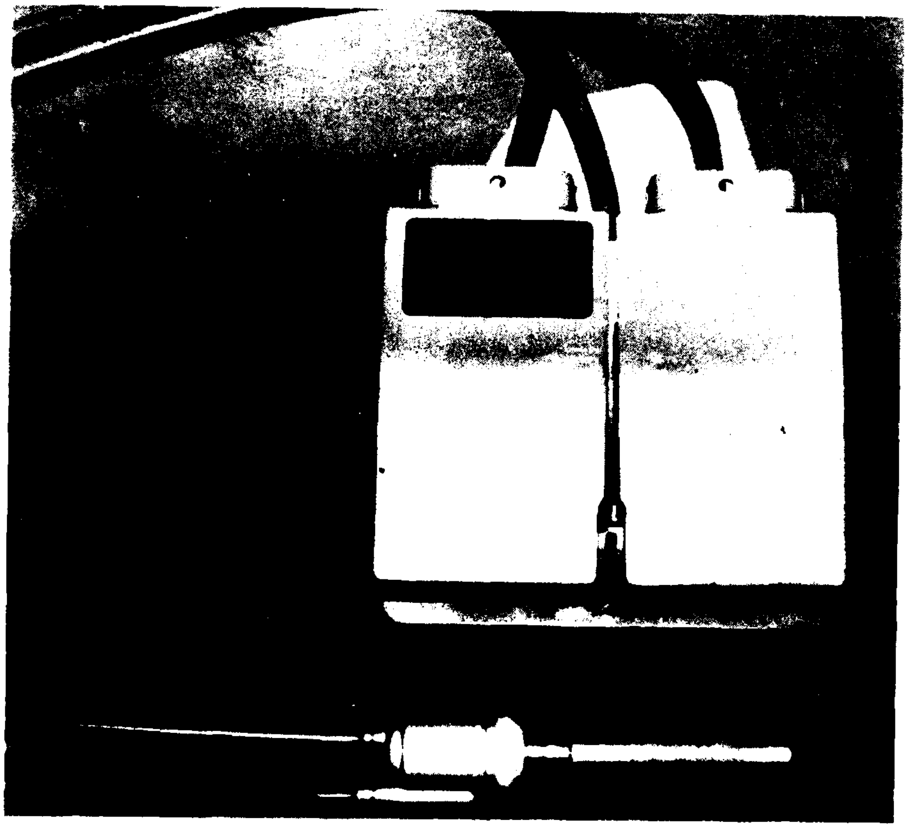

Figure 1. Ney T-200 Air-driven Handengine.

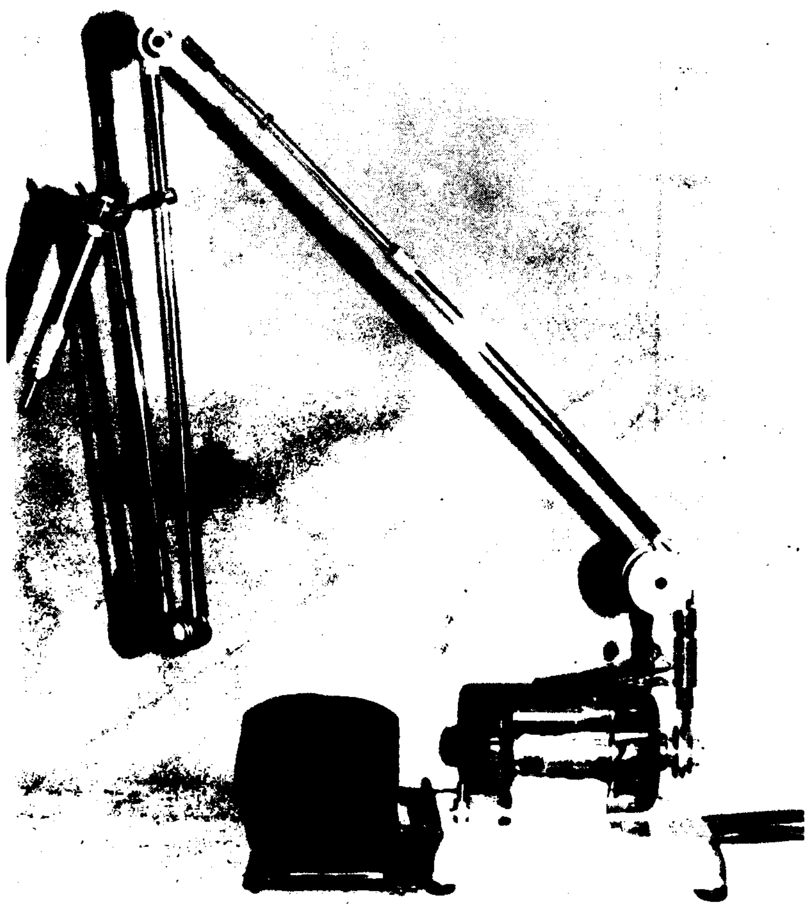

Figure 2. Buffalo 1/5 hp Belt-driven Handengine.

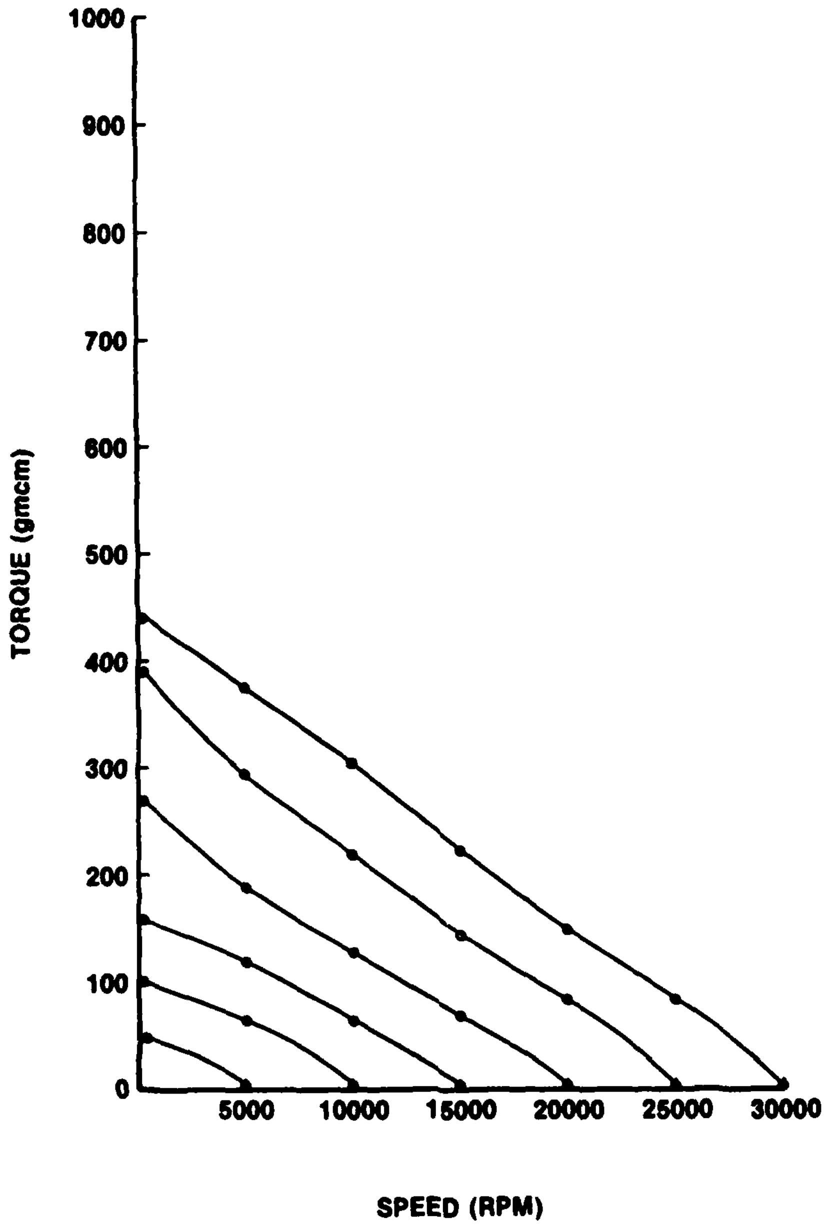

Figure 3. Ney T-200: torque vs. speed curves.

FARO MFL Micromotor

The FARO MFL Micromotor (Fig. 18) was evaluated with two different power units. The FC 81 power unit (Fig. 18) was a floor foot control. The LC 81 power unit (Fig. 19) was countertop mounted with a foot-pedal control. The torque vs. speed curves for the MFL Micromotor at various starting speeds are given in Figure 20. A UC 81 is also available with the handengine mounted on a spring-based handpiece holder rod above the unit.

The users felt that the handengine started slow and had poor torque. The handengine was bulky in the palm of the hand. The rheostat was an on/off switch and was difficult to operate. The LC 81 unit was large and cluttered the work area. The UC 81 handengine holder was awkward and the spring mechanism was too short. Medical maintenance personnel felt that the power unit had easy access for maintenance, but there was inadequate literature provided for local servicing.

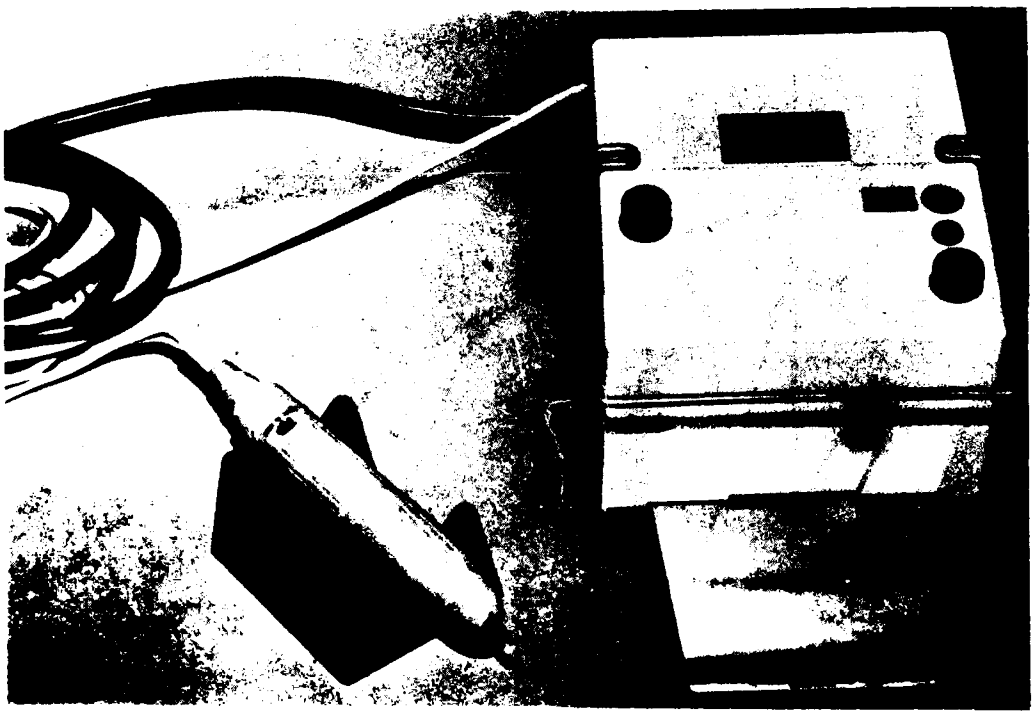

Figure 18. FARO MFL Micromotor with FC 81 Power Unit.

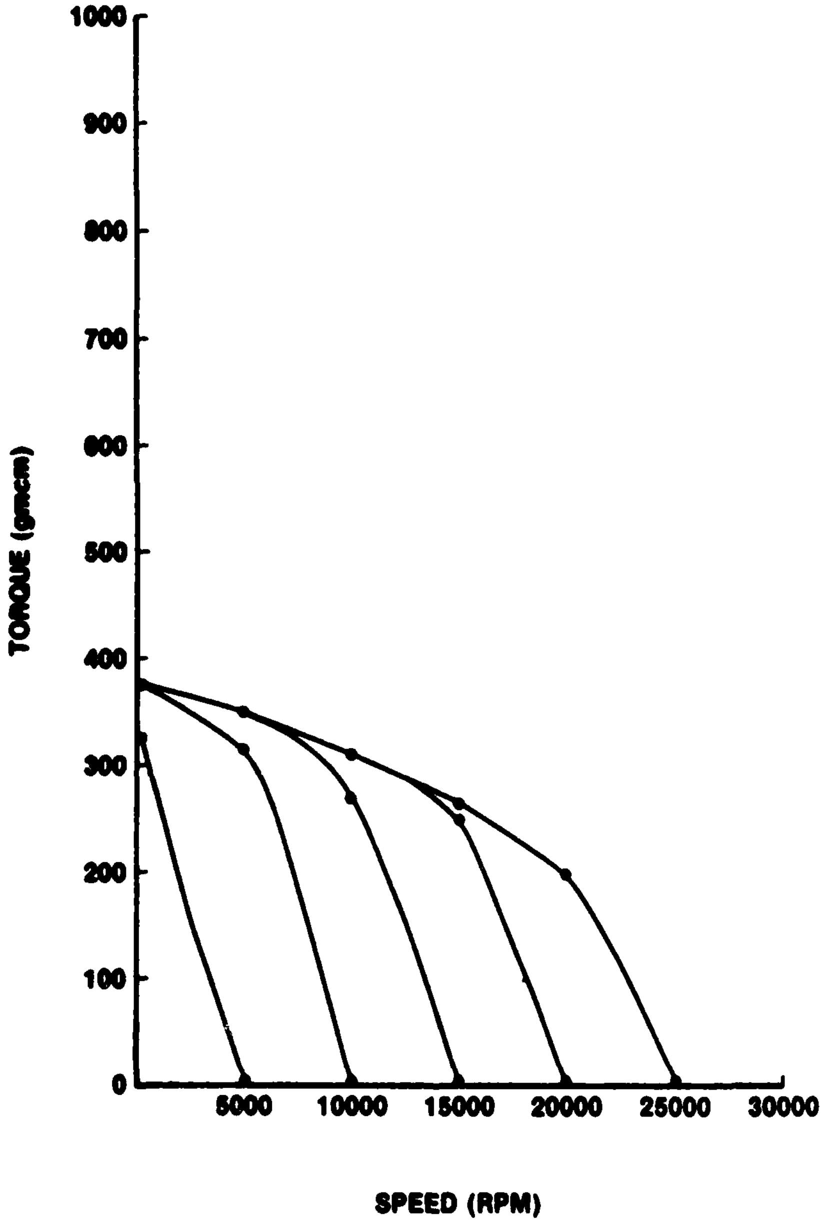

Figure 17. KaVo 950: torque vs. speed curves.

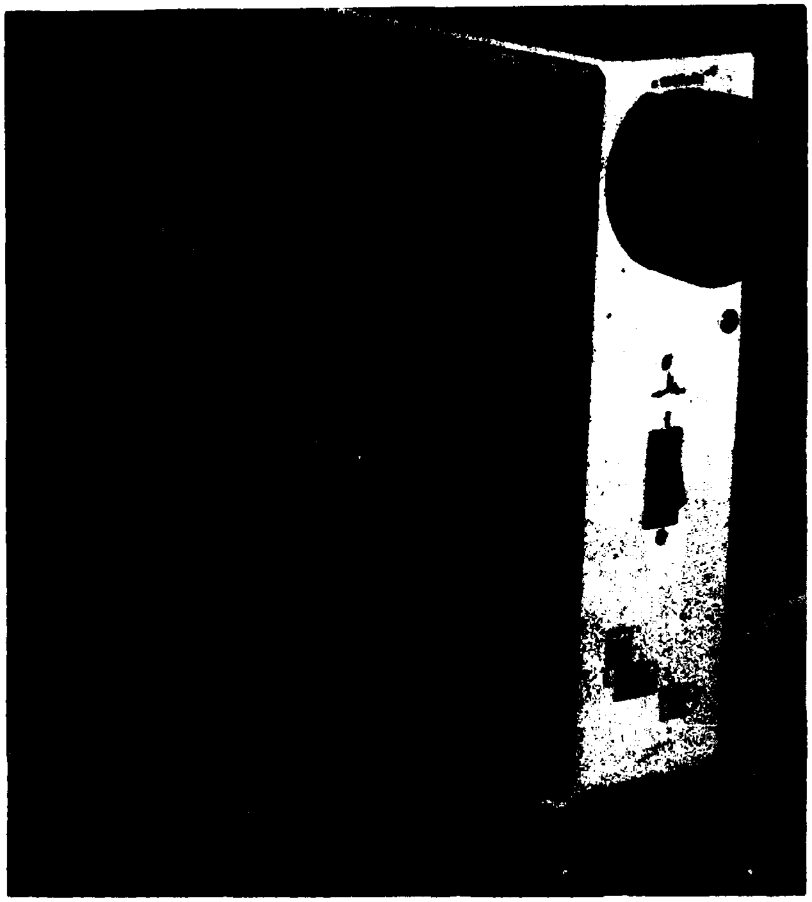

Figure 16. KaVo 950 with K9 EWL 920 Power Unit.

KaVo 950 (K9 EWL) Handengine

The KaVo 950 handengine was evaluated with two different K9 EWL power units. The 900 power unit (Fig. 15) was foot controlled and the 920 power unit was knee controlled (Fig. 16). The units are available for 100V/50-60 Hz, 110V/50-60 Hz, 120V/50-60 Hz, 220V/50 Hz, and 240V/50 Hz. A 970 handengine is available with International Standards Organization (ISO) coupling and a countertop, 915, power unit is also available. The torque vs. speed curves for the 950 handengine at different starting speeds are given in Figure 17. The curves were the same for both the 900 and 920 power units.

The users felt that the 950 handengine was too large to hold. The handengine has good torque and a good variable speed rheostat. The 920 knee control power unit was preferred since the 900 power unit got in the way on the floor. Medical maintenance personnel felt that the unit had easy access for maintenance.

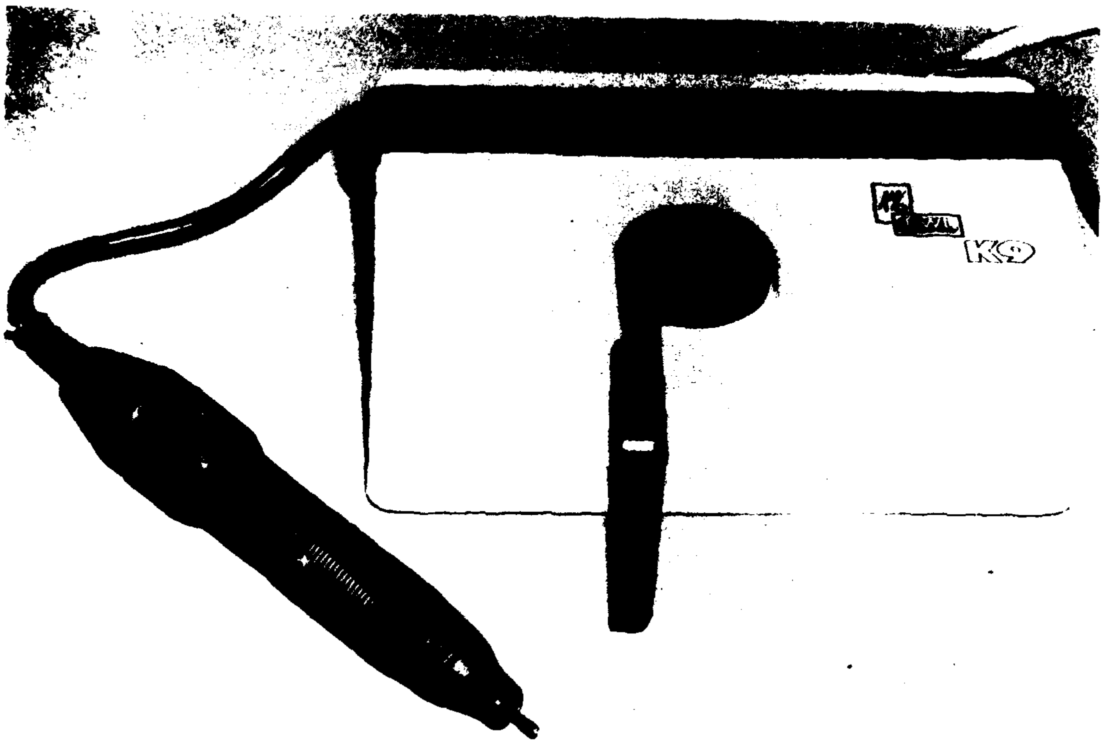

Figure 15. KaVo 950 with K9 EWL 900 Power Unit.

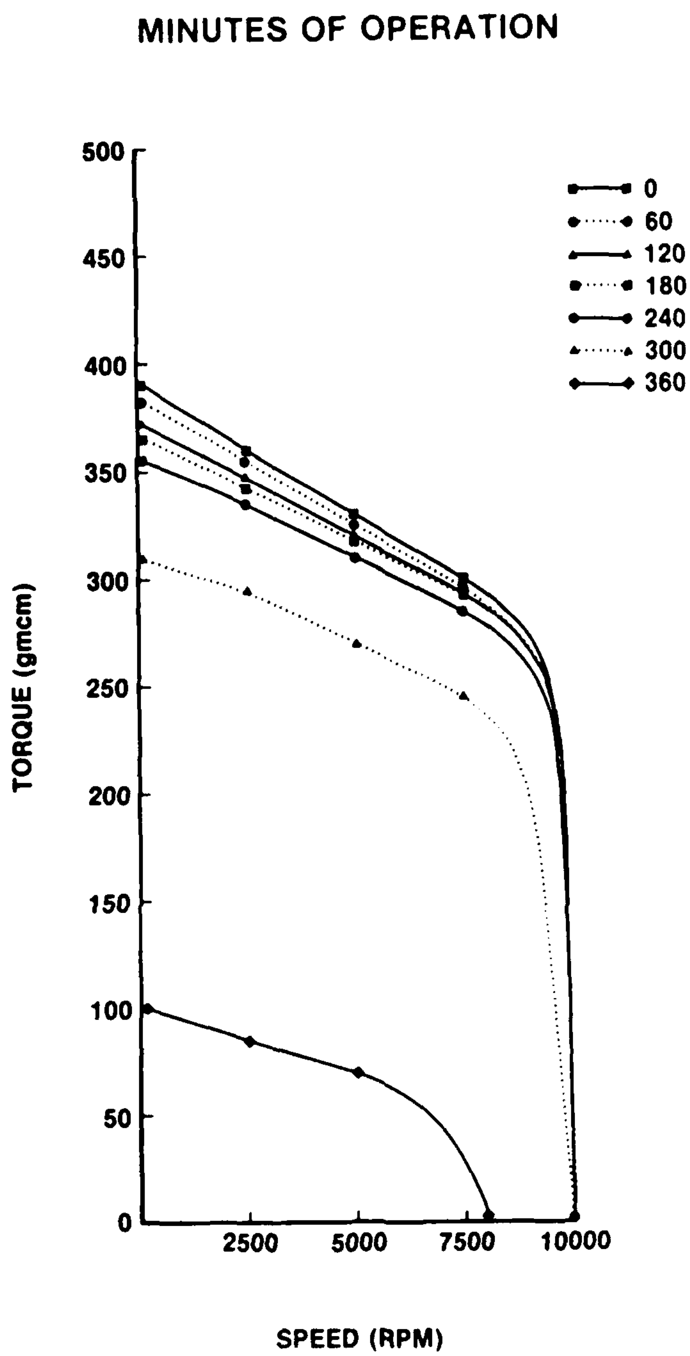

Figure 14. Bell Mark VIII Life Test: torque vs. speed curves.

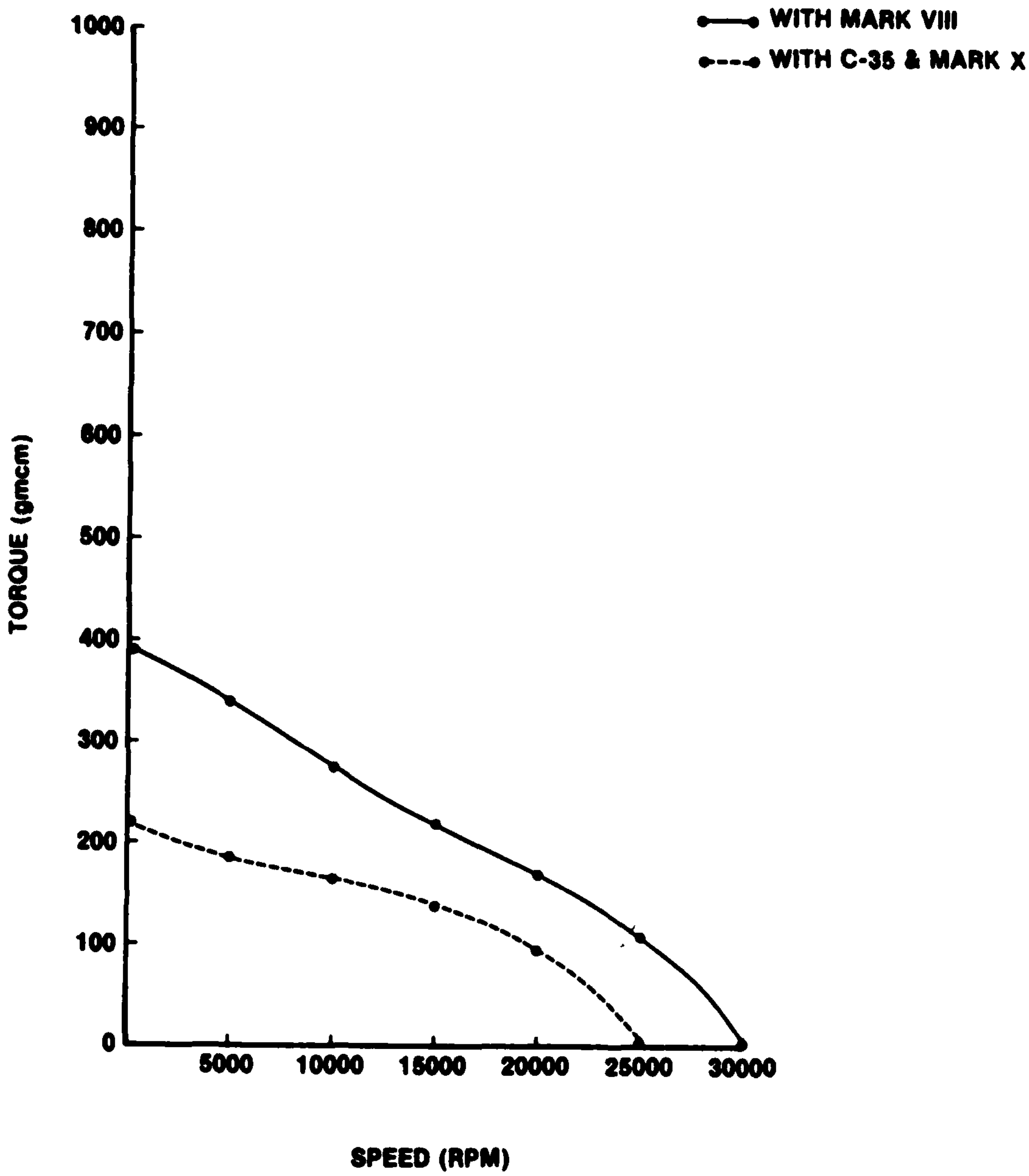

Figure 13. Bell 28L: torque vs. speed curves.

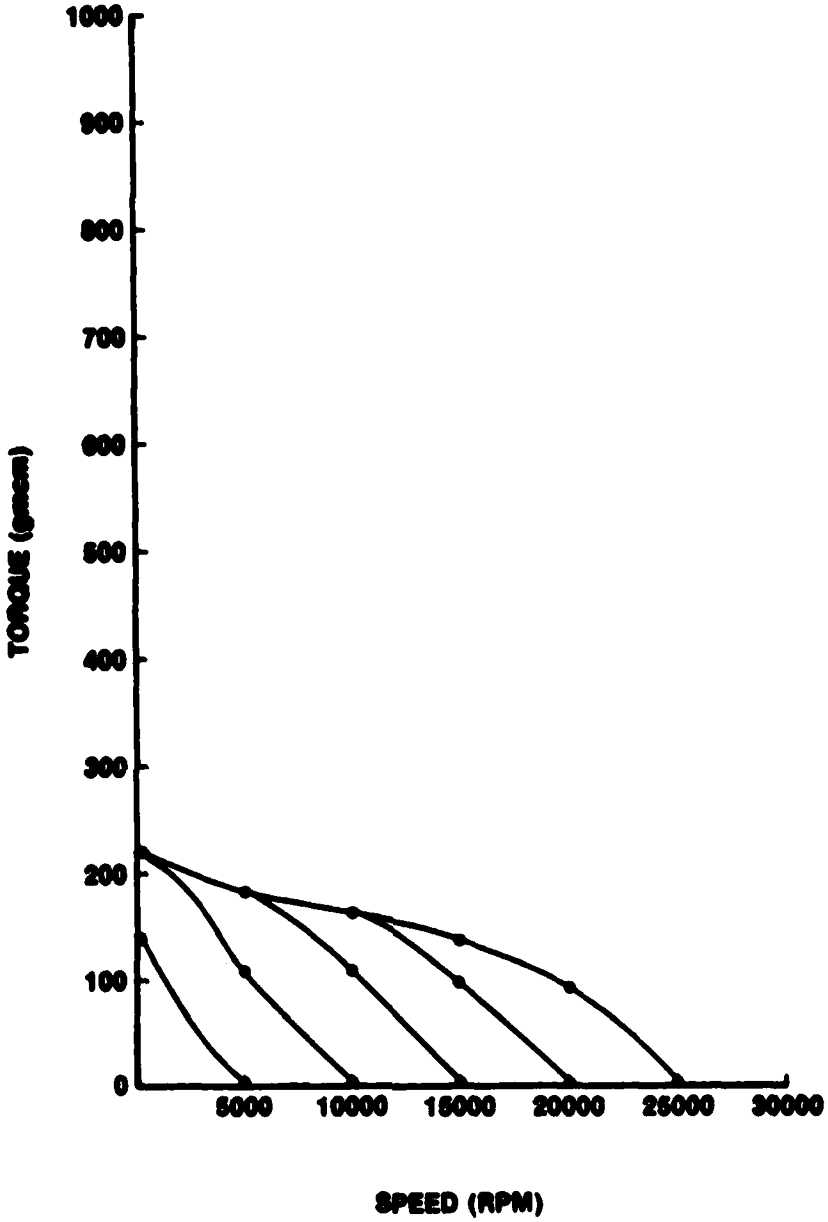

Figure 12. Bell 28L with C-35: torque vs. speed curves.

Bell 28L Handengine

The Bell 28L Handengine was evaluated with the C-35 (Fig. 11) Mark VIII and Mark X power units. The 28L handengine torque with varying starting speeds are given in Figure 12. The torque vs. speed curves for the 28L are given in Figure 13. The curves were identical for the C-35 and Mark X power units. The 28L was operated continuously on the Mark VIII battery without recharging. The change in torque over a 6-hr period is shown in Figure 14. However, during the user evaluation, the Mark VIII was used in normal operation for 2 weeks without noticeable change in torque without recharging.

The users felt that the 28L was very similar to the Bell 38L and that there was no noticeable difference in operation. Medical maintenance personnel found that the circuit boards had poor workmanship and displayed signs of overheating. The unit would be difficult to service locally.

Figure 11. Bell 28L and C-35 Power Unit

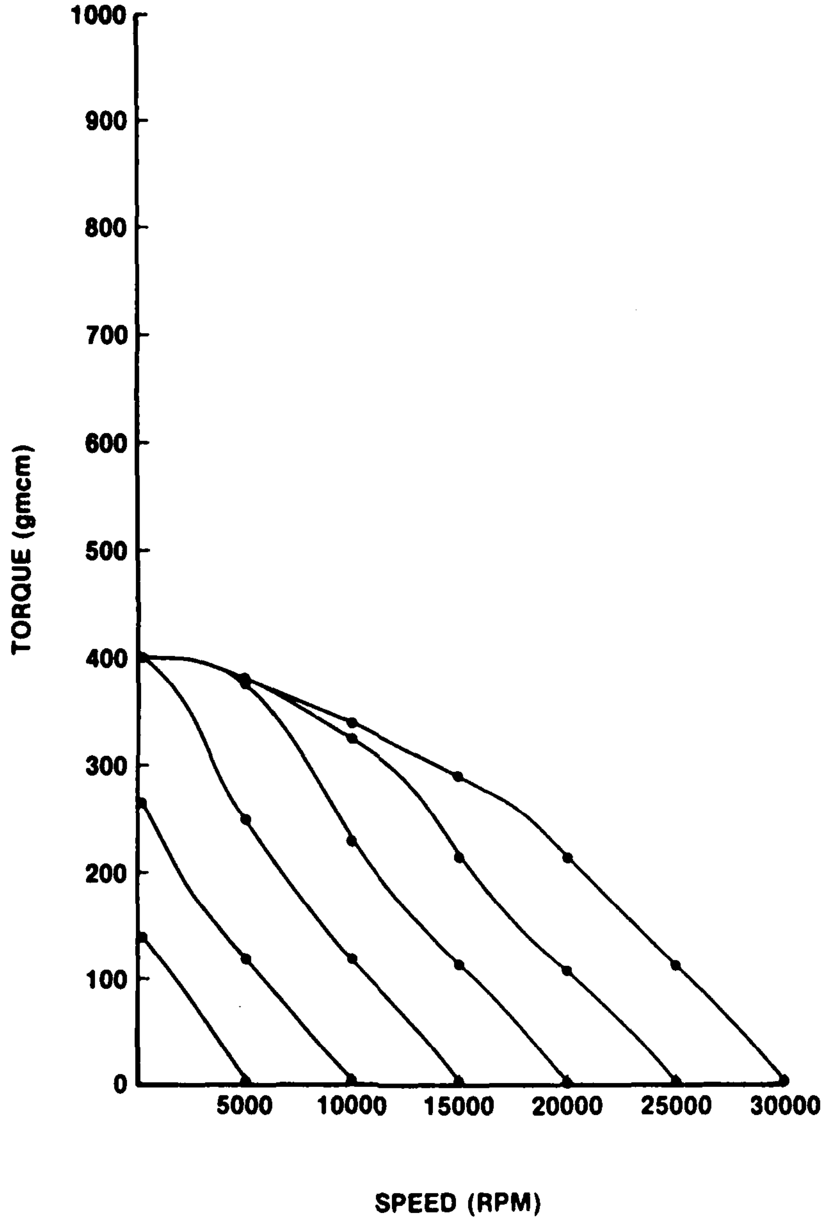

Figure 10. Bell 38L with C-33: torque vs. speed curves.

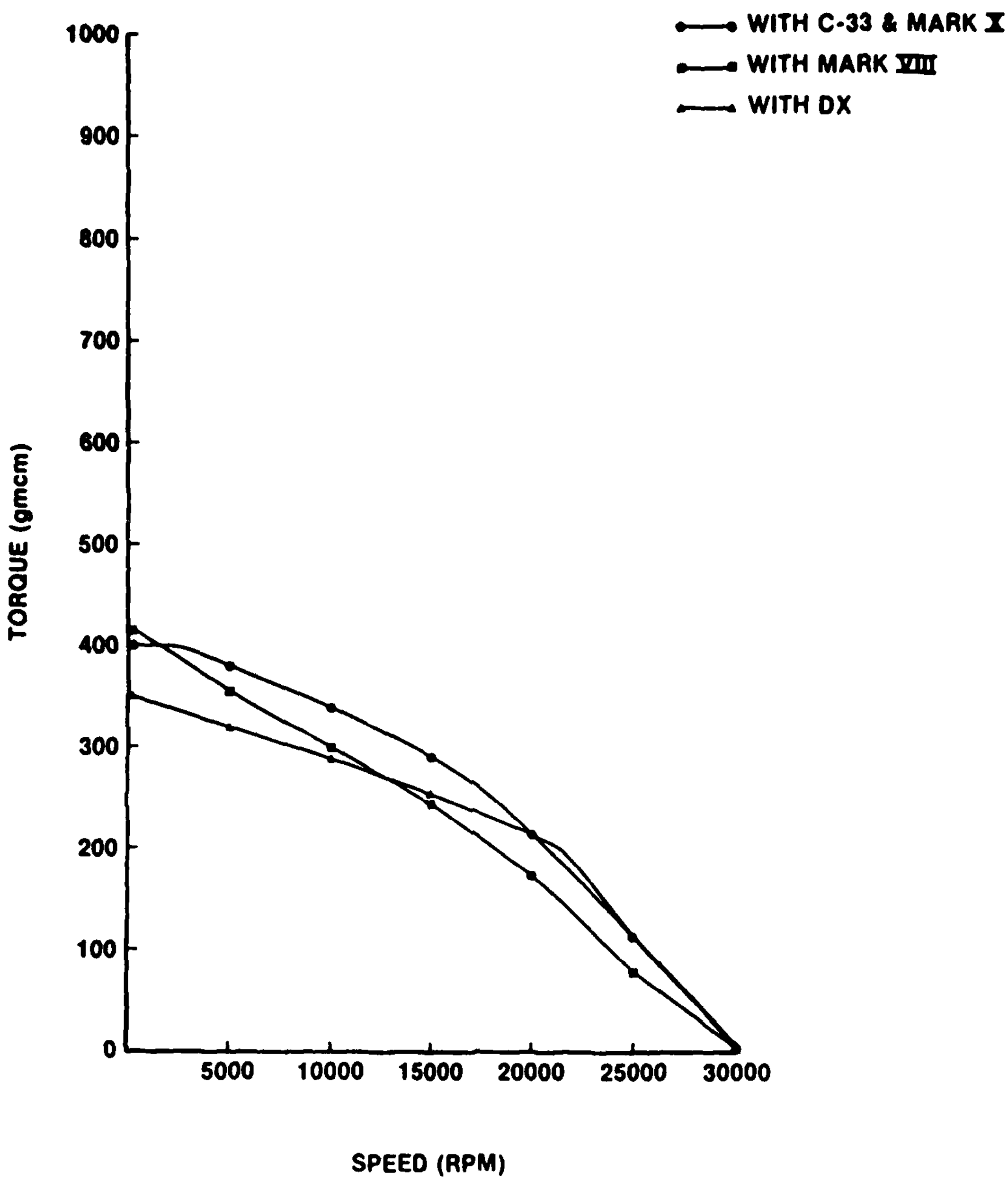

Figure 9. Bell 38L: torque vs. speed curves.

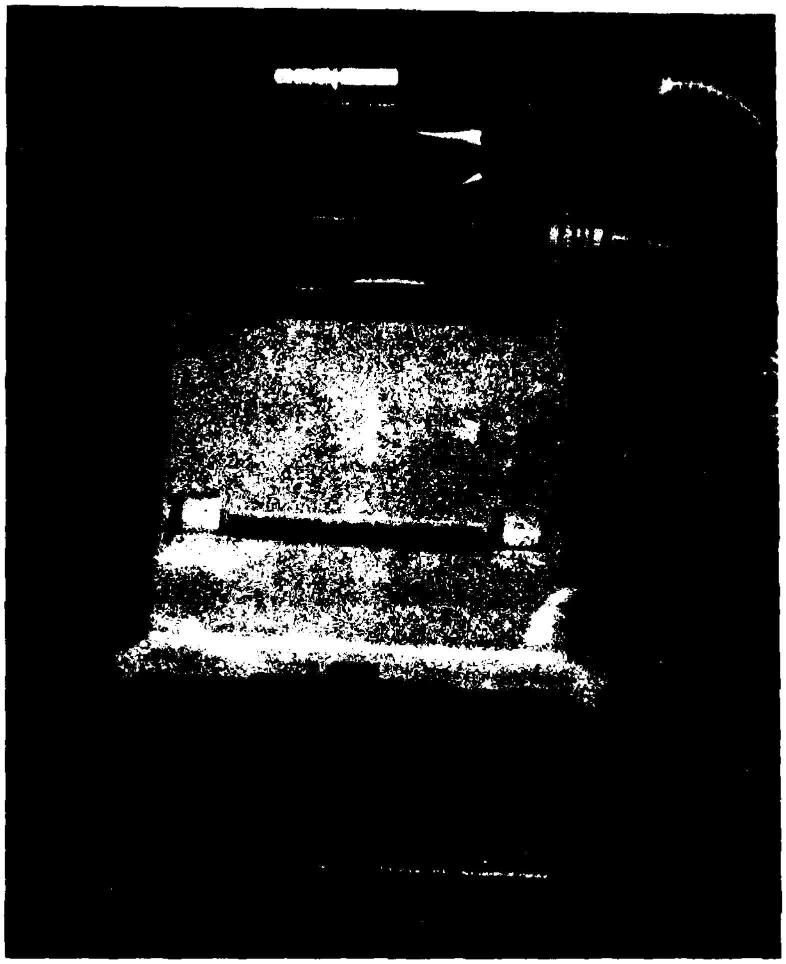

Figure 8. Bell DX Power Unit.

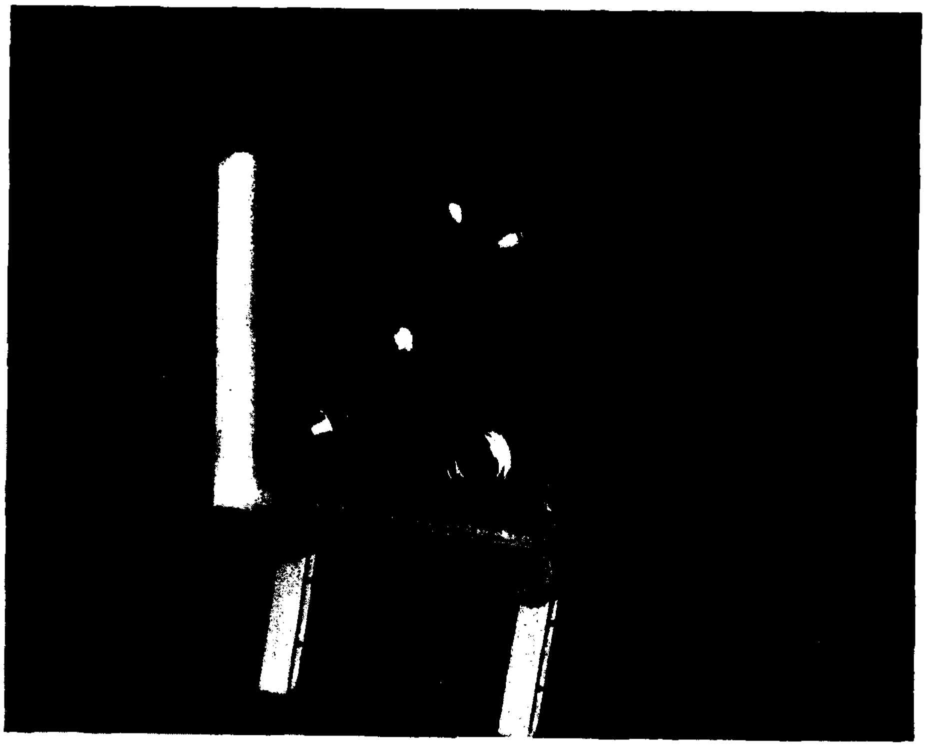

Figure 6. Bell Mark VIII Rechargeable Power Unit.

Figure 7. Bell Mark X Power Unit.

Bell 38L Handengine

The Bell Royal 38L Handengine was evaluated with four different power units. The C-33 (Fig. 5) had a countertop control box with optional on/off foot-pedal control and was available in 100-120V or 220-240V configurations. The Mark VIII power unit (Fig. 6) could be used connected to a power source or as a rechargeable power pack. The Mark X power unit (Fig. 7) was a foot-controlled rheostat. The DX power unit (Fig. 8) was a foot-controlled on/off switch with rheostat.

The users felt that the 38L handengine had good torque, had good shape, and fit the palm of the hand comfortably. The burs were difficult to change on the handengine. The DX power unit took considerable adjustment for ease of control.

The torque vs. speed curves for the 38L with the different power units are given in Figure 9. The curves were identical for the handengine when used with the C-33 and Mark X power units. The 38L performance, when torque was applied at varying starting speeds, is given in Figure 10. Medical maintenance personnel found that the circuit boards had poor workmanship and displayed signs of overheating. The unit would be difficult to service locally.

Figure 5. Bell 38L Handengine and C-33 Power Unit.

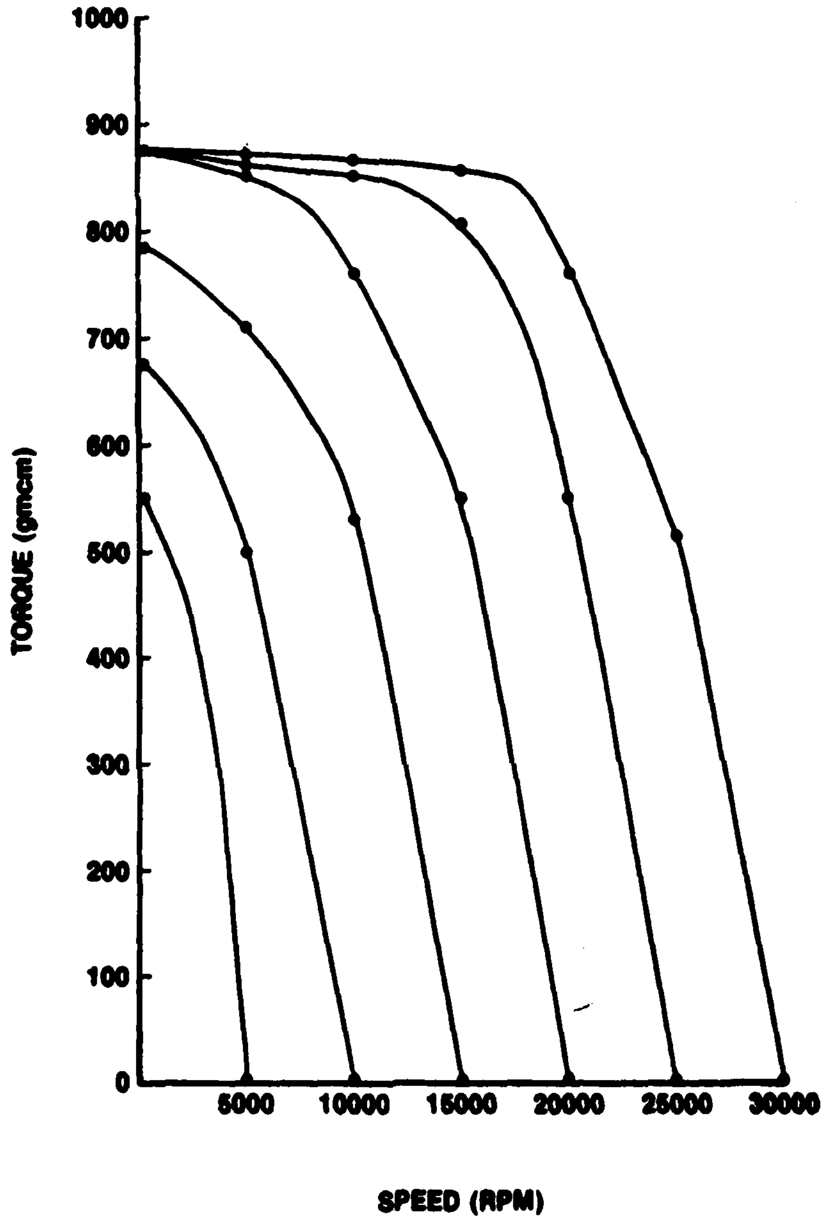

Figure 4. Buffalo 1/5 hp: torque vs. speed curves.

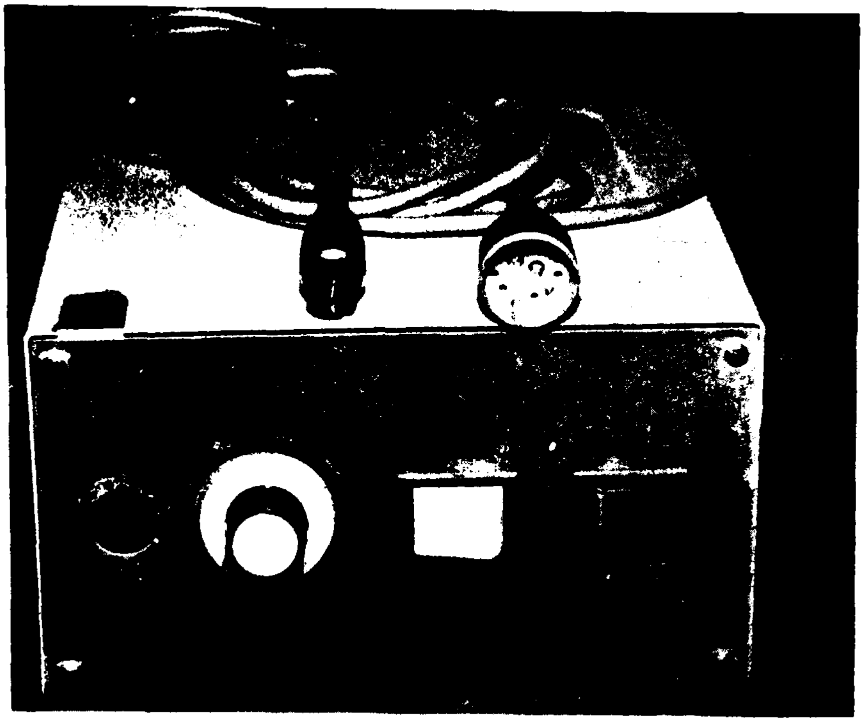

Figure 19. FARO MFL Micromotor with LC 81 Power Unit.

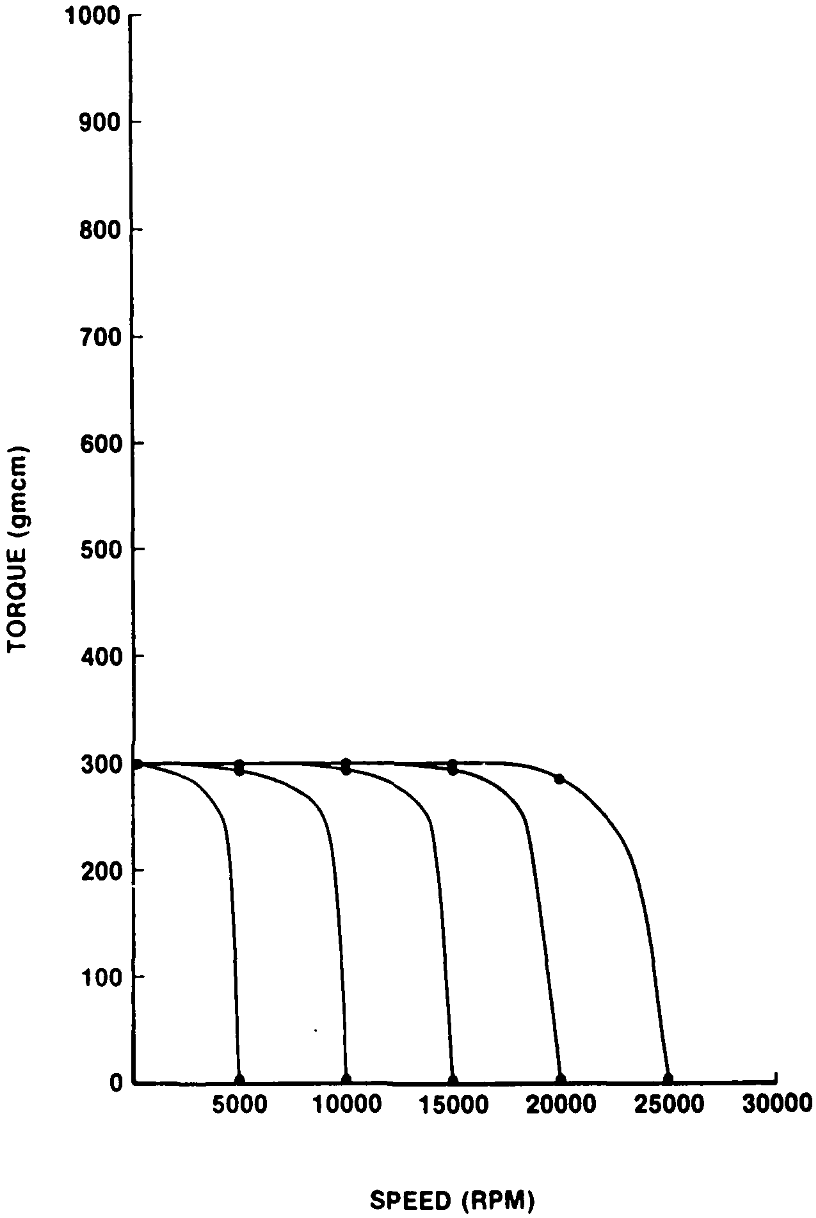

Figure 20. FARO MFL Micromotor: torque vs. speed curves.

Erio Odontomotor

A user evaluation was performed on the Erio Odontomotor (Fig. 21). The torque vs. speed curves at various starting speeds are given in Figure 22.

The users felt that the Odontomotor handengine had excellent torque. The handengine was compact in size. The unit came with many bulky pieces that cluttered the work area. The collets had very small tolerances, and some burs would not fit. The users did not like the rheostat since it had to be set and then operated by an off/on switch. The settings did not allow for fine control of speed. Medical maintenance personnel found that the knee switch was unreliable and easy to break. Spring-action swaying of switch would continuously turn the motor on and off. The handengine would heat up during operation. The power unit had excellent workmanship and good internal components.

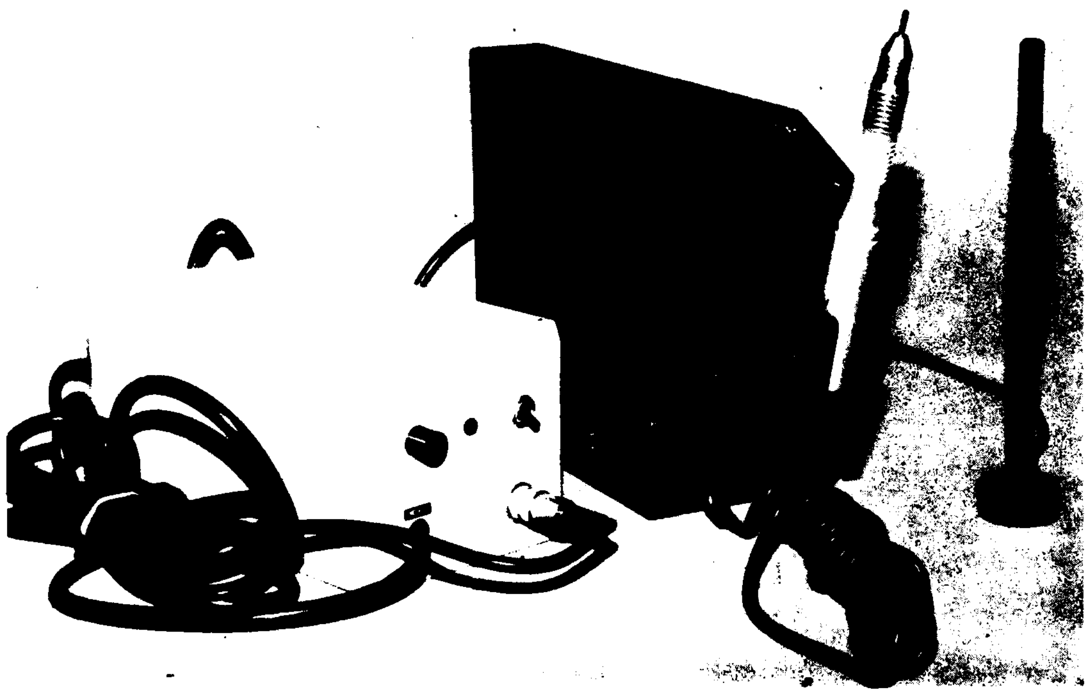

Figure 21. Erio Odontomotor.

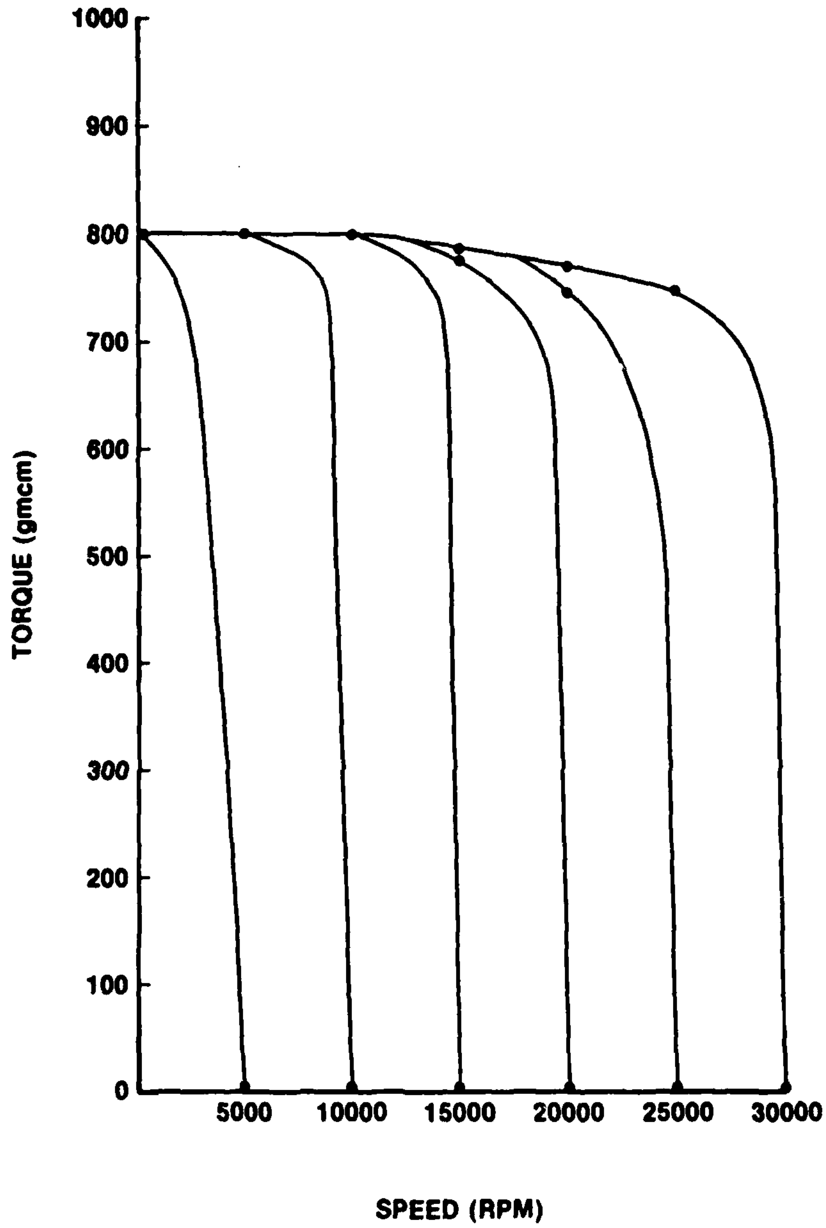

Figure 22. Erio Odontomotor: torque vs. speed curves.

Handler Syncro/Torque Handengine

The Handler Syncro/Torque handengine was evaluated with the Model 500 series power unit (Fig. 23). The torque vs. speed curves for various starting speeds are given in Figure 24.

The users felt that the Syncro/Torque handengines became warm after extended use. The handengines had to be maintained with lubricant. The cord attachment would fall into the unit when disconnected. Both handengines malfunctioned during user evaluation. Medical maintenance personnel found that the system was prone to failure and that local maintenance was impossible.

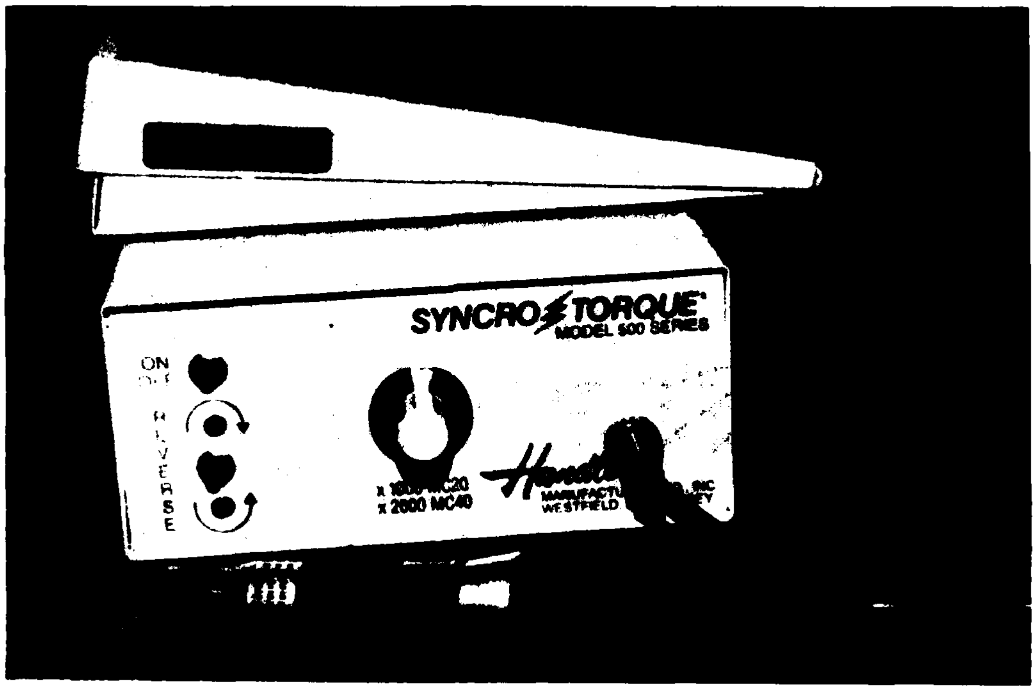

Figure 23. Handler Syncro/Torque Model 500 Series Power Unit,

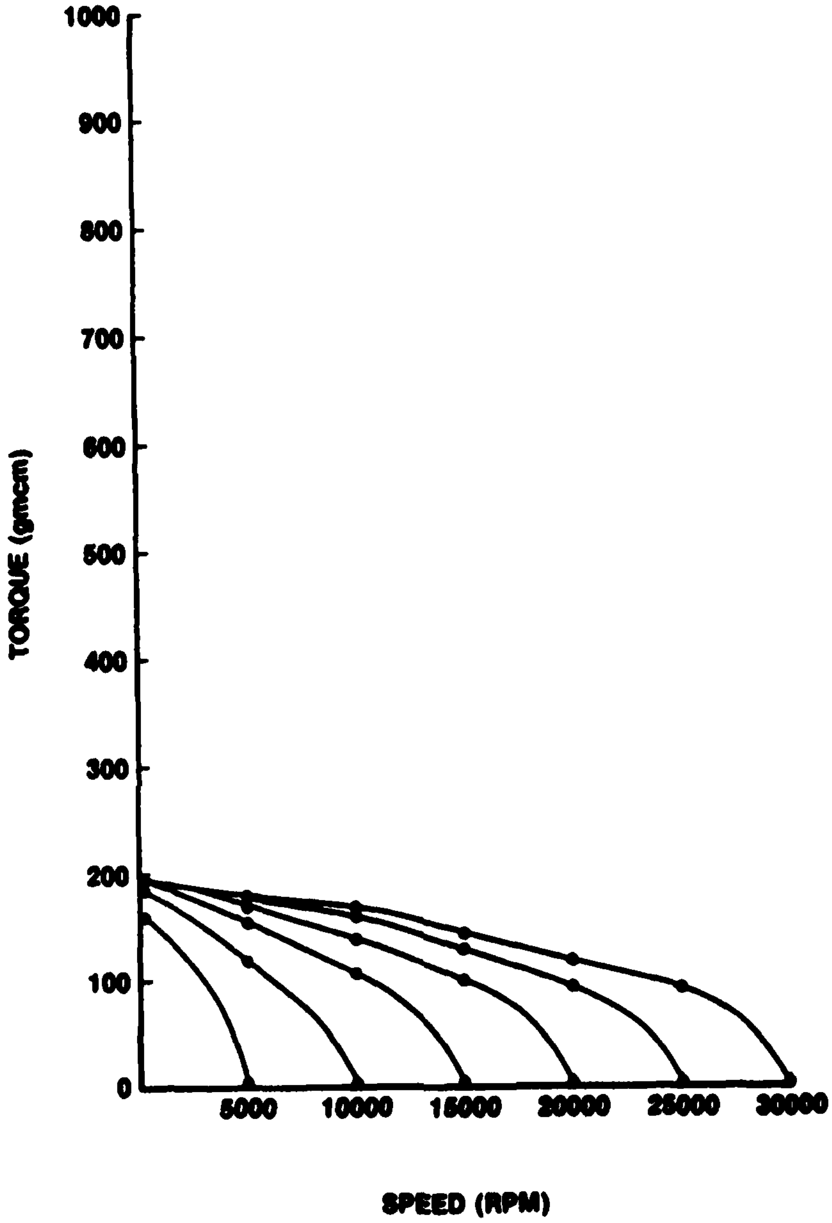

Figure 24. Handler Syncro/Torque: torque vs. speed curves.

Jelenko Dynamo 35 Handengine

A user evaluation was performed on the Jelenko Dynamo 35 Handengine (Fig. 25). The power unit was available in 120V/50-60 Hz and 240V/50-60 Hz. The torque vs. speed curves at various starting speeds are given in Figure 26.

The users felt that the handengine fit the palm of the hand comfortably. The control box was small and had a foot-pedal control. The handengine was slow to start and had poor torque. The reset button popped out easily under heavy loads. The handengine was basically the same as the Bell 28L. Medical maintenance personnel found that the circuit boards were difficult to remove. The components did not fit the circuit boards. The circuit runs were also broken and dirty.

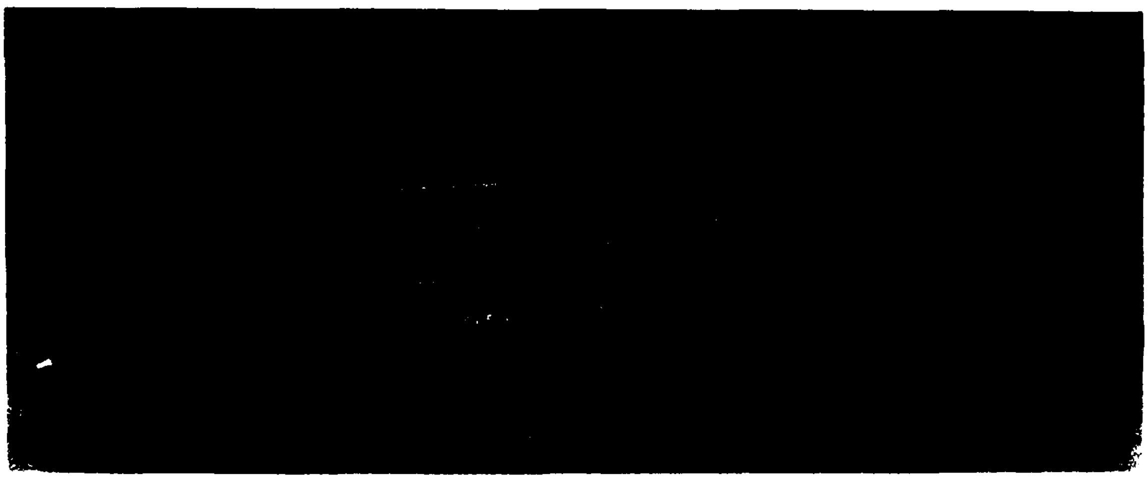

Figure 25. Jelenko Dynamo 35.

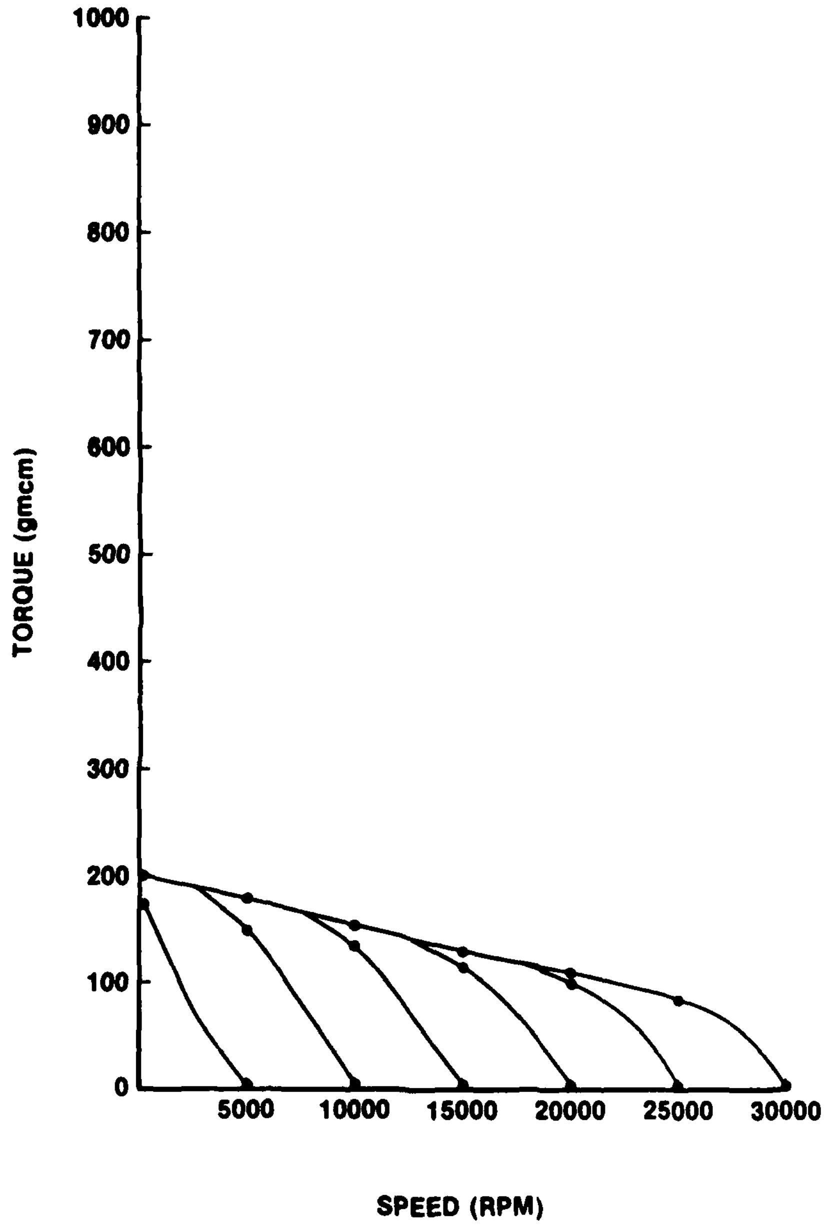

Figure 26. Jelenko Dynamo 35: torque vs. speed curves.

Teledyne Emesco 15 EHA Micro-Motor

The Teledyne Emesco Micro-Motor was evaluated with the 15 EHA power unit (Fig. 27). The EHA is 110V and is available in 220V as the EHB. The torque vs. speed curves at various starting speeds are given in Figure 28.

The users felt that the Micro-Motor had excellent workmanship and had plenty of torque. The handengine was large. The foot control unit was heavy and difficult to move around. Medical maintenance personnel found that the circuit boards were easily removed for troubleshooting and repair. Components were easily cross-referenced. The unit was constructed of highly durable plastic.

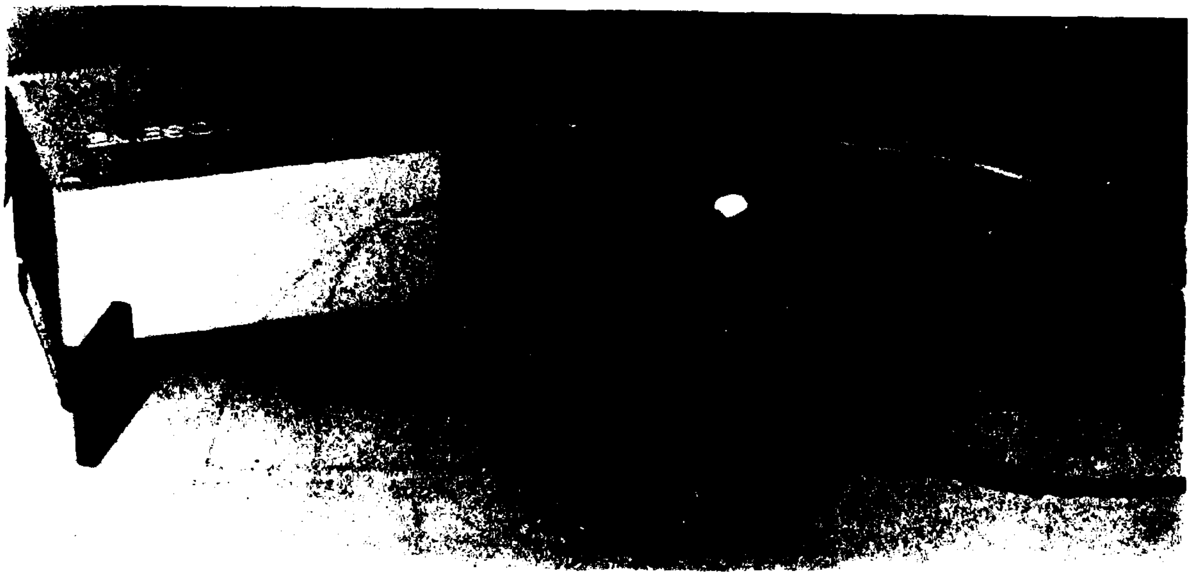

Figure 27. Teledyne Emesco Micro-Motor with 15 EHA Power Unit.

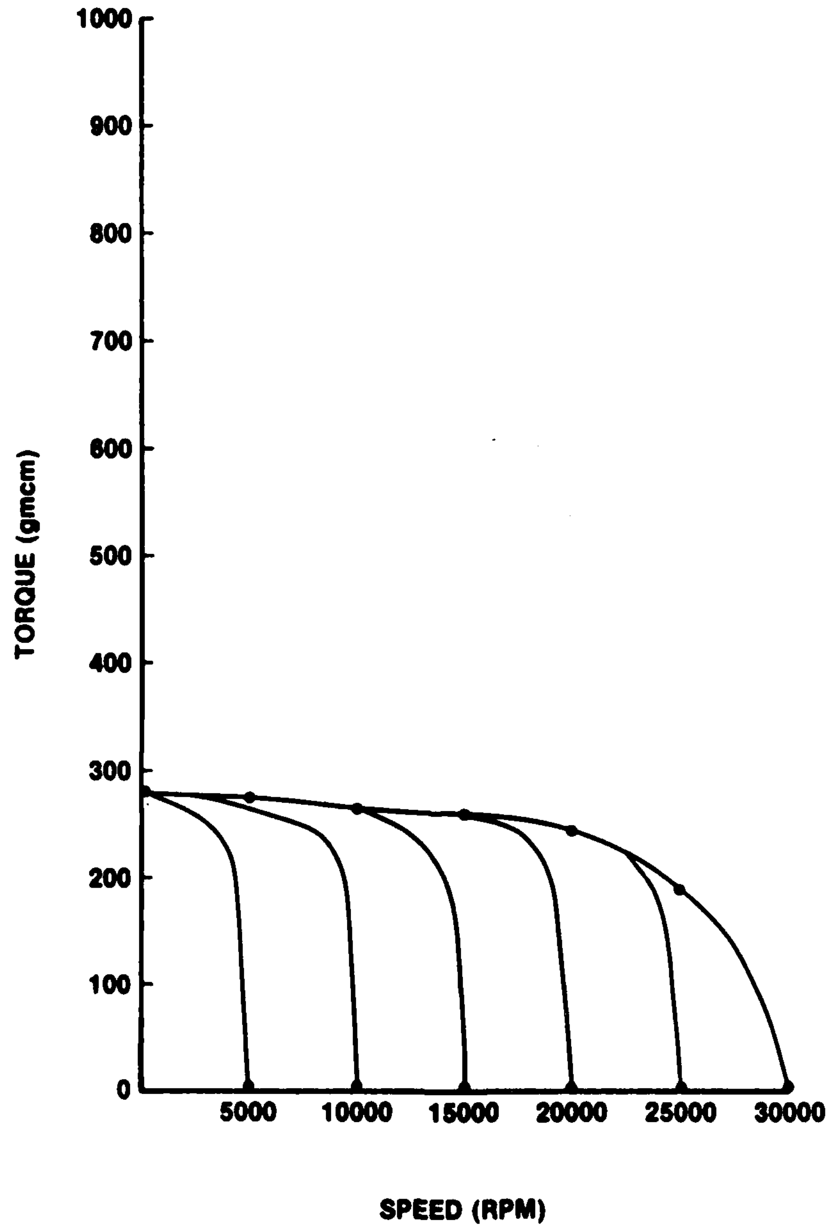

Figure 28. Teledyne Emesco Micro-Motor: torque vs. speed curves.

Unitek Electric Handpiece

A user evaluation was performed on the Unitek Electric Handpiece (Osada of Japan). (Fig. 29). The power unit is 100V/50-60 Hz. The torque vs. speed curves at various starting speeds are given in Figure 30. Note how the unit would sense torque and provide extra power to increase the torque in the lower speed ranges.

The users felt that the handpiece was skillfully built, fit the palm of the hand comfortably, and had plenty of torque. All controls were conveniently placed and compact. Burs were easy to change. The rheostat was a variable-speed foot pedal. The majority of the evaluators chose this handpiece over the others. Medical maintenance personnel found that the components and circuit boards were easy to remove and repair, but the literature was inadequate. This handpiece did not operate as smoothly as the others.

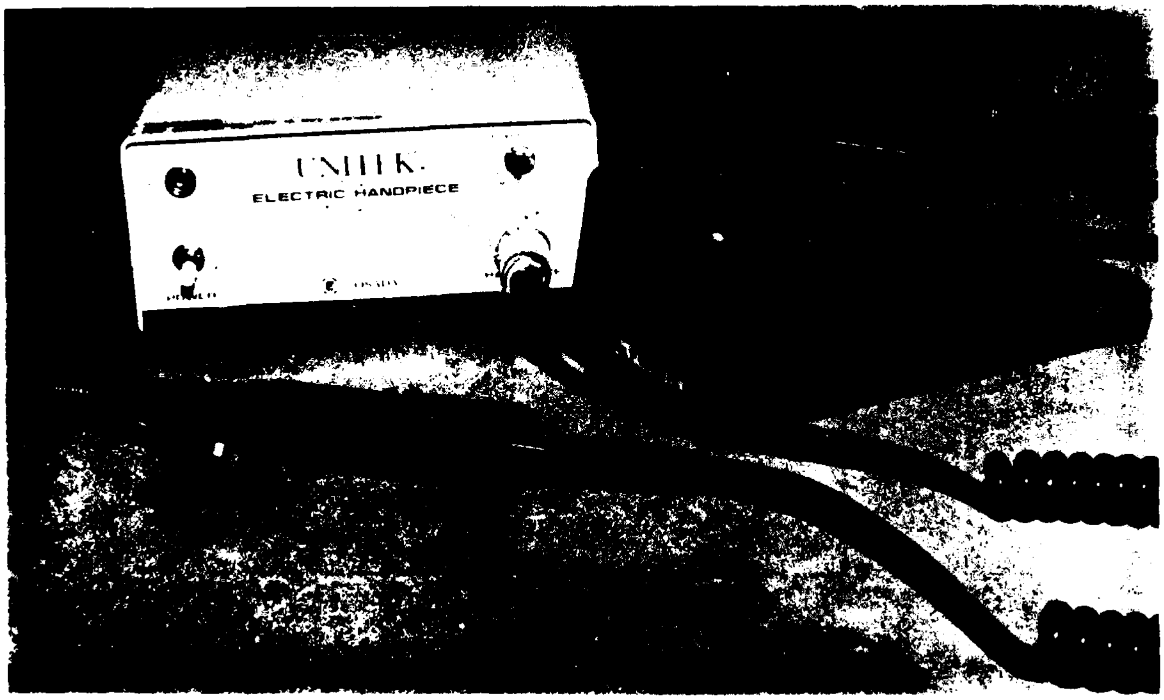

Figure 29. Unitek Electric Handpiece.

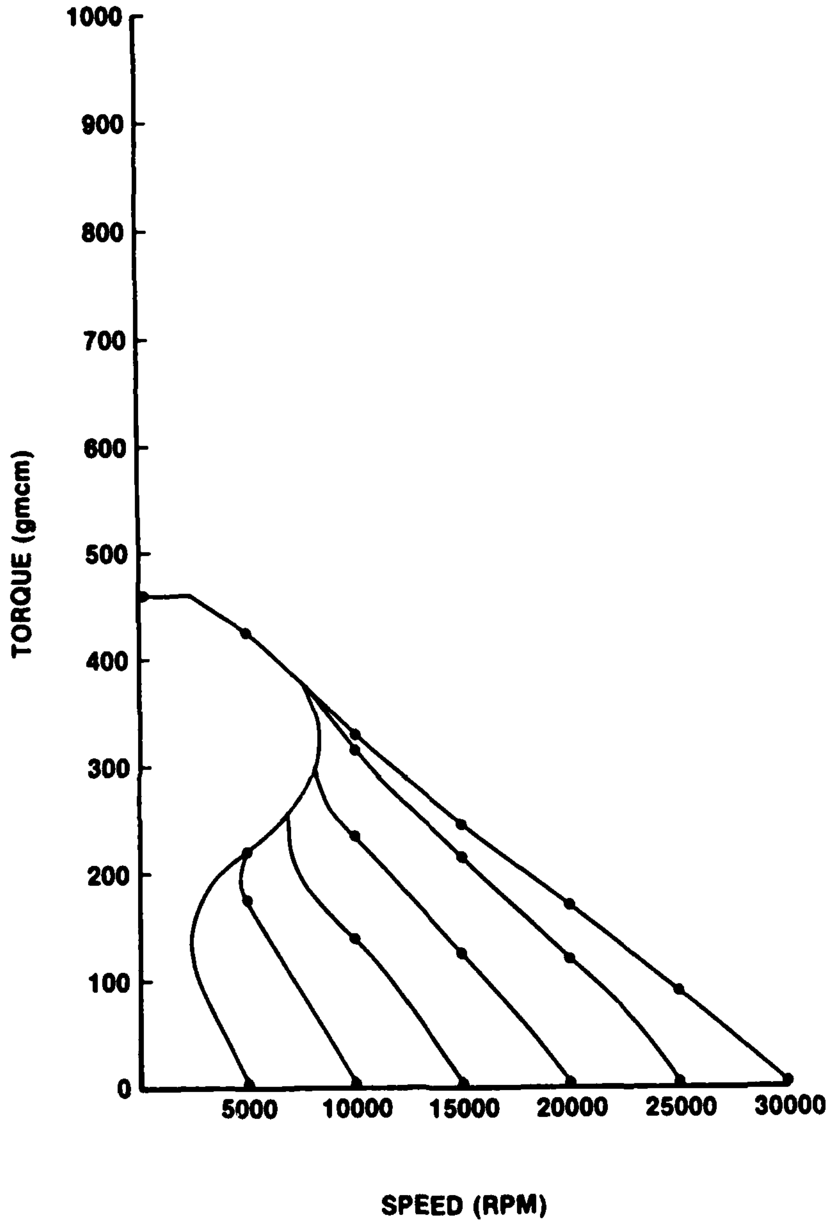

Figure 30. Unitek Handpiece: torque vs. speed curves.

CONCLUSIONS

A comparison of the physical characteristics of the dental electric handengines is given in Table 2. The comparison of torque and power of the various units is shown in Figures 31 and 32.

The selection of dental electric handengines depends almost entirely upon the needs of the respective dental clinic and the laboratory technicians. All units tested essentially performed the tasks for which they were designed. The ease of repair, size, and portability should be weighed according to local demands.

The information provided by this report can be used by the base dental surgeon as an aid in purchasing dental laboratory handengines. Any questions should be directed to the U.S. Air Force Dental Investigation Service, USAFSAM/NGD, Brooks AFB TX 78235-5301, Autovon 240-3502, Commercial (512) 536-3502.

TABLE 2. COMPARISON OF HANDENGINE CHARACTERISTICS

Unit	Weight (g)	Sound (dB)	Unit size (in.)	Cord (ft)	Fuse/Breaker
Bell 38L	217	58.6	8 x 6 x 3 1/2	7	External fuse
Bell 28L	220	53.7	8 x 6 1/4 x 3 1/2	7	External fuse
KaVo	346	64.9	7 7/8 x 5 x 3	7	Breaker
FARO	258	51.1	7 1/4 x 7 3/4 x 4 1/2	3	External fuse
Erio	265	59.2	8 1/2 x 5 x 4 1/2	6 1/2	External fuse
Handler	250	54.8	6 1/2 x 3 x 6 1/2	7	External fuse
Jelenko	220	53.6	7 1/8 x 5 3/8 x 3 1/2	6 1/2	External fuse
Teledyne	310	52.8	5 x 7 x 4 1/2	8	Breaker
Unitek	260	52.3	6 x 5 1/2 x 3	5 1/2	External fuse
Ney (Air)	144	84.3	N/A	5	N/A
Buffalo (Belt)	198	73.1	6 x 9 x 7	3 1/4	N/A

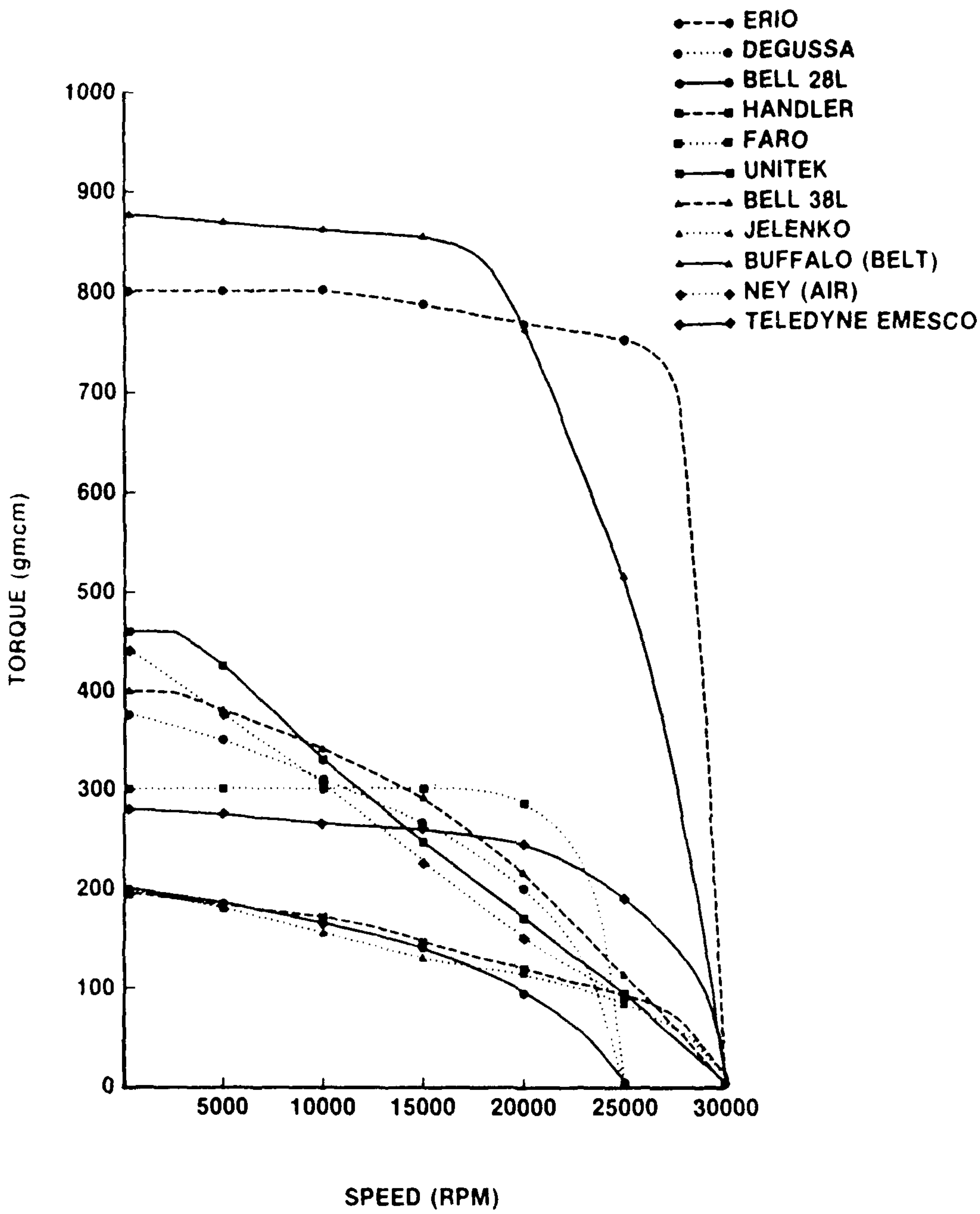

Figure 31. Comparison of torque vs. speed curves.

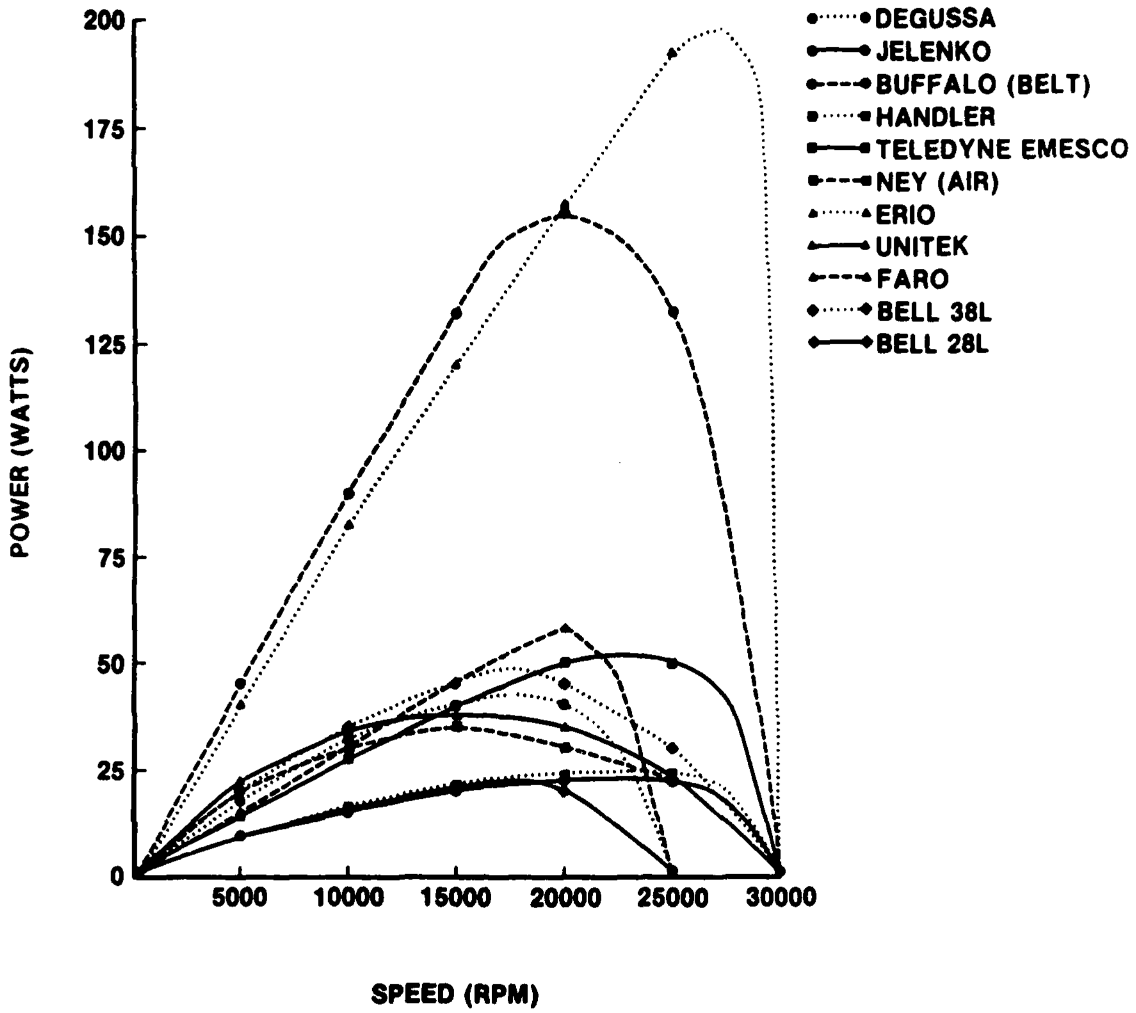

Figure 32. Comparison of power curves.

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